WHAT IS CLAIMED IS:

1. An image processing apparatus for assuming a characteristic of a virtual image sensing optical system, and applying a blur effect corresponding to a preset in-focus state to a captured image, comprising:

an image input unit for capturing image information including distance information to each portion of an object to be photographed;

a parameter input unit for inputting a parameter from which an effective aperture and focal length of the assumed image sensing optical system can be derived;

an in-focal pint position designation unit for designating an in-focal pint position of the assumed image sensing optical system;

a blur state calculation unit for calculating a blur state from the distance information input by said image input unit, the in-focal pint position designated by said in-focal pint position designation unit, and the parameter input by said parameter input unit; and

an image processing unit for applying the blur effect to the image input by said image input unit in correspondence with the blur state calculated by said blur state calculation unit.

2. An image processing apparatus for applying a blur effect to a captured image, comprising:

an image input unit for capturing image

information including distance information to each

portion of an object to be photographed; and

an image processing unit for applying the blur

effect to the image input by said image input unit by

5   overwrite sequentially from an image portion having far

distance information.

3.   An image processing apparatus for applying a

blur effect to a captured image, comprising:

an image input unit for capturing image

10   information;

an image processing unit having a first operation

mode of applying the blur effect to only part of the

image input by said image input unit, and a second

operation mode of applying the blur effect to a

15   remaining image portion;

a switching unit capable of externally switching

an operation mode of said image processing unit from

the first operation mode to the second operation mode;

and

20   a display unit capable of displaying an image

blurred by said image processing unit.

4.   An image processing apparatus for assuming a

characteristic of a virtual image sensing optical

system, and applying a blur effect corresponding to an

25   in-focus state to a captured image, comprising:

an image input unit for capturing image

information including distance information to each

portion of an object to be photographed;

a parameter input unit for inputting a parameter from which an effective aperture and focal length of the assumed image sensing optical system can be

5   derived;

an in-focal pint position designation unit for designating an in-focal pint position of the assumed image sensing optical system;

a confusion circle calculation unit for

10   calculating a confusion circle from the distance information input by said image input unit, the in-focal pint position designated by said in-focal pint position designation unit, and the parameter input by said parameter input unit;

15   a blur state calculation unit for calculating a blur state using a point spread function (PSF) within a range corresponding to a size of the confusion circle calculated by said confusion circle calculation unit; and

20   an image processing unit for applying the blur effect to the image input by said image input unit in correspondence with the blur state calculated by said blur state calculation unit.

5.   An image processing method of assuming a

25   characteristic of a virtual image sensing optical system, and applying a blur effect corresponding to a preset in-focus state to a captured image, comprising

the steps of:

capturing image information including distance information to each portion of an object to be photographed;

inputting a parameter capable of deriving an effective aperture and focal length of the assumed image sensing optical system;

designating an in-focal pint position of the assumed image sensing optical system;

calculating a blur state from the input distance information, the designated in-focal pint position, and the input parameter; and

applying the blur effect to the input image in correspondence with the calculated blur state.

6. An image processing method of assuming a characteristic of a virtual image sensing optical system, and applying a blur effect corresponding to an in-focus state to a captured image, comprising the steps of:

capturing image information including distance information to each portion of an object to be photographed;

inputting a parameter from which an effective aperture and focal length of the assumed image sensing optical system can be derived;

designating an in-focal pint position of the assumed image sensing optical system;

calculating a confusion circle from the input distance information, the designated in-focal pint position, and the input parameter;

calculating a blur state using a point spread

5   function (PSF) within a range corresponding to a size of the calculated confusion circle; and

applying the blur effect to the input image in correspondence with the calculated blur state.

7.   An image processing method of applying a blur

10   effect to a captured image, comprising the steps of:

capturing image information including distance information to each portion of an object to be photographed; and

applying the blur effect to the input image by

15   overwrite sequentially from an image portion having far distance information.

8.   An article of manufacture comprising:

a computer-readable storage medium having computer-readable program code means stored to assume a

20   characteristic of a virtual image sensing optical system and apply a blur effect corresponding to a preset in-focus state to a captured image in an image processing apparatus, said computer-readable program code means comprising:

25   first computer-readable program means for providing a computer with a function of capturing image information including distance information to each

portion of an object to be photographed;

second computer-readable program means for providing the computer with a function of inputting a parameter from which an effective aperture and focal length of the assumed image sensing optical system can be derived;

third computer-readable program means for providing the computer with a function of designating an in-focal pint position of the assumed image sensing optical system;

fourth computer-readable program means for providing the computer with a function of calculating a blur state from the input distance information, the designated in-focal pint position, and the input parameter; and

fifth computer-readable program means for providing the computer with a function of applying the blur effect to the input image in correspondence with the calculated blur state.

9. An article of manufacture comprising:

a computer-readable storage medium having computer-readable program code means stored to assume a characteristic of a virtual image sensing optical system and apply a blur effect corresponding to an in-focus state to a captured image in an image processing apparatus, said computer-readable program code means comprising:

first computer-readable program means for providing a computer with a function of capturing image information including distance information to each portion of an object to be photographed;

5   second computer-readable program means for providing the computer with a function of inputting a parameter from which an effective aperture and focal length of the assumed image sensing optical system can be derived;

10   third computer-readable program means for providing the computer with a function of designating an in-focal pint position of the assumed image sensing optical system;

fourth computer-readable program means for

15   providing the computer with a function of calculating a confusion circle from the input distance information, the designated in-focal pint position, and the input parameter;

fifth computer-readable program means for

20   providing the computer with a function of calculating a blur state using a point spread function (PSF) within a range corresponding to a size of the calculated confusion circle; and

sixth computer-readable program means for

25   providing the computer with a function of applying the blur effect to the input image in correspondence with the calculated blur state.

10. An article of manufacture comprising:

a computer-readable storage medium having
computer-readable program code means stored to apply a
blur effect corresponding to an in-focus state to a
5   captured image in an image processing apparatus, said
computer-readable program code means comprising:

first computer-readable program means for
providing a computer with a function of capturing image
information including distance information to each
10   portion of an object to be photographed; and

second computer-readable program means for
providing the computer with a function of applying the
blur effect to the input image by overwrite
sequentially from an image portion having far distance
15   information.

11. An image processing apparatus comprising:

means for inputting image data including depth
information;

means for setting a parameter for expressing a
20   lens characteristic;

means for setting any one of a focal length,
F-number, field angle, and effective aperture;

means for setting a distance for adjusting a
focus;

25   means for calculating expression of an image
texture including a blur from the virtual camera
setting values and the depth information of the image;

does not mention virtual camera

and

means for storing a calculation result in a memory.

12. An apparatus according to claim 11, further comprising means for inputting an image having depth information in units of pixels of a two-dimensional image.

13. An apparatus according to claim 11, wherein a blur function is a point spread function (PSF) calculated in units of pixels from the focal length of a lens, the F-number or aperture, the object distance, and the depth information of the image.

14. An apparatus according to claim 11, wherein a blur function has a variable function shape, and is a concave function or convex function determined by a focal pint position and an object distance to be calculated.

15. An apparatus according to claim 11, wherein a user can freely change, with a volume, the F-number and a focal pint position designated by the user, and a calculation result using a thumbnail image obtained by thinning out an input image is displayed to interactively obtain confirmable parameter setting.

16. An apparatus according to claim 11, wherein a user designates a position on a window to determine a focal pint position using depth information of the window.

17. An apparatus according to claim 11, wherein a

user freely changes the F-number with a volume while

designating a focal pint position on a designated

window, and a calculation result using a thumbnail

image obtained by thinning out an input image is

5   displayed to interactively obtain parameter setting

capable of confirming designation of the focal pint

position and the F-number.

18.   An apparatus according to claim 11, wherein a

user can change a zoom ratio by changing an f-number.

10   19.   An apparatus according to claim 11, wherein a

central point of a zoom and a position to get into

focus are set in setting a zoom ratio, and central

coordinates of the zoom and depth information of the

point are used to calculate enlargement on a window and

15   a blur state or to interactively determine a parameter.

20.   An apparatus according to claim 19, wherein an

outer frame in an area to be enlarged and displayed

without changing a display ratio is displayed in

setting the zoom ratio.

20   21.   An apparatus according to claim 11, wherein a

window is enlarged based on central coordinates of a

zoom designated by a user, a focal pint position on the

window is designated to determine the focal pint

position, the F-number is freely changed with a volume,

25   and a calculation result using a thumbnail image

obtained by thinning out an input image is displayed to

interactively obtain parameter setting capable of

confirming designation of a central position of the field angle, a zoom ratio, and the F-number.

22. An apparatus according to claim 11, wherein a blur state is expressed using influence of coma which changes depending on a distance and azimuth from a center of an image.

23. An apparatus according to claim 11, wherein an asymmetrical point spread function is calculated for coma using a blur function obtained by shifting a central position of a radius of a confusion circle in accordance with a distance from a central position of an image.

24. An apparatus according to claim 11, wherein influence of chromatic aberration is adopted.

25. An apparatus according to claim 11, wherein a range $d-\Delta$ from $\underline{d}$ on a point spread function for a radius (d) of a symmetrical confusion circle is set as a chromatic aberration influence range, and red aberration or blue aberration is applied.

26. An apparatus according to claim 11, wherein influence of a color shift in air is used.

27. An apparatus according to claim 11, wherein a blue range or red range of a color characteristic at not less than a given distance is emphasized or decreased.

28. An apparatus according to claim 11, further comprising means for inputting, as a set of units,

depth information and image information in units of

pixels or areas for each object.

29. An apparatus according to claim 11, wherein an

input image is a set of objects having a predetermined

5   distance in units of not pixels but sets of objects.